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JULY-SEPTEMBER 1974

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Teledyne Geotech

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SEISMIC DATA ANALYSIS CENTER QUARTERLY TECHNICAL SUMMARY REPORT  
JULY-SEPTEMBER 1974

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## ABSTRACT

This report is a summary of the technical work accomplished at the Seismic Data Analysis Center (SDAC) during the third quarter of 1974. Part A summarizes the seismological findings which were approved for distribution during the period. Part B describes system development work associated with the expanded VELA network, and Part C is a review of accomplishments within the operating systems at the SDAC.

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## A. SEISMOLOGICAL RESEARCH

One report (SDAC-TR-74-8) was released for publication and distribution during the quarter. The following discussion summarizes that report.

This report discusses the Rayleigh wave detection rates, missed signal rates, and false alarm rates measured at the three long period arrays LASA, ALPA, and NORSAR during the International Seismic Month.

The method utilized FKCOMB, a program which computes a three dimensional Fourier transform in frequency-wave number space for overlapping four minute windows. The Rayleigh wave from a listed event was declared detected if an energy peak greater than some minimum threshold appeared in the predicted time and azimuth windows, with an acceptable period and group velocity. False alarm rates were estimated by attempting to detect Rayleigh waves ostensibly coming from a fictitious epicenter list. The procedure is quantitative and can be automated on a digital computer.

Results show that the 5-dimensional window in time, azimuth, velocity, period and signal size is an effective way to analyze the output of FKCOMB. Moreover the limits on these variables for signal acceptance are easy to quantify and are readily programmable on a digital computer. Most detections acceptable through the 5-dimensional window are large signals (F-statistic greater than 20). Only 6% of the detections at ALPA and 12% at LASA are recorded in the lower threshold.

In the case of long-period network detection (at least 2 of 3 LP arrays detecting the signal) 3 out of 4 ISM events with  $m_b$ 's from 4.5 to 4.9 at all depths are detected. Only 1 out of 3 events in the  $m_b$  4.0 to 4.4 range are detected. For events listed as shallow (less than 100 km deep) by the ISM epicenter list 3 out of 4 events in the range  $m_b$  4.5 to 4.9 are detected and slightly less than 50% in the range  $m_b$  4.0 to 4.4 are detected by the LP network (2 out of 3 LP arrays). For events listed as deep (greater than 100 km) by the ISM epicenter list, 62% are detected in the range  $m_b$  4.5 to 4.9 and 1 out of 3 are detected in the range  $m_b$  4.0 to 4.4 by the LP network (2 out of 3 LP arrays).

At all 3 LP arrays the  $M_s/m_b$  plots for the events detected do not show appreciably higher  $M_s$  values for shallow events (less than 100 km) as compared to the deep events. This same result is true even when the shallow/deep separation is 50 km rather than 100 km.

Results also show that more than half of the false alarms at any of the 3 LP arrays occurs above the upper threshold in the 5-dimensional window. No raising of this detection threshold would appreciably cut the false alarm rate without drastically reducing the true-signal detection rate at each array.

Finally, the combination of requiring detection by 2 of 3 arrays coupled with the requirement that all detections be in the upper threshold reduces the false alarm rate from 5 in 37 to 1 in 37 and decreases the true detection rate from 83 in 192 (43%) to 71 in 192 (37%).



## B. NETWORK RESEARCH

At the SDAC we are involved in three efforts directly related to the expanded VELA seismic network. The first concerns certain revisions we are making in the LASA processing system (LASAPS) at the LASA data center (LDC) in Billings, Montana. The second is the requirements for us to modify the current Detection Processor (DP) at the SDAC. The third task specifies the design and implementation of a Network Event Processor (NEP). The completion of the first two tasks will make it possible for us to handle data from the reconfigured LASA. The third effort will enable us to work with inputs from several stations in the determination of seismic event parameters. The following is a review of the significant accomplishments in these efforts during the quarter:

LDC - The design of the LASAPS revisions was completed in August. For this design we assumed that there will be minimal changes in the format of data input to LASAPS. We received approval from VSC for the revised documentation plan.

Also in August we finished the comparison of data recorded on the PDP-7 at LDC and that recorded by ISRSPS during a test of a version of LASAPS, reconstructed from source. Plots of LDC data matched plots of SDAC data closely.

In September we issued a purchase order for the rental equipment which is required for testing the revised LASA processing system at the LASA Data Center (LDC) in Billings, Montana. Work has started on a tape-input and tape-output version of LASAPS which will utilize this equipment.

DP - During the quarter a discussion and review of the DP design was held with VSC. Further discussions will be held with VSC on data editing and detection algorithms, after which the design for these areas will be finalized. Following a complete review of Network transmission formats and Mass Store structures, the input/output data formats for DP will be finalized.

The coding of the DP program module which accepts tape input as opposed to inputs from the CCP continued. This is a test module. The 360/91 at UCLA was used for interactive coding and editing. The TS44 system at SDAC was used to transfer the resultant code to SDAC for testing with the DP system. The coding of the executive module was begun.

NEP - A new Design Team was formed that immediately set about revising the draft of the NEP Preliminary Design Report. All effort during July was directed toward completing this document.

The technical evaluation of bids for the NEP disk system were completed, and MEMOREX was the successful bidder. This equipment will be installed in October of this year.

Work continues on the draft of the preliminary NEP Graphics Console Users Specifications. This document describes the seismic processing options available to the analyst. Further definition of the minimum graphics capability requirement was obtained, and the DEC 44 Graphics System was investigated. We determined that it does not possess the minimum graphics capability required.

Work continues on defining the NEP software structure. A first version of MAINTASK was coded, and initial data structure designs for the PAQTASK, PROCESSING TASK, and ANALYST TASK were completed.

ILLIAC - In July we wrote draft documentation for DEM1, DEM2, and FKCOMB, and we completed the draft of our report on the suitability of ILLIAC for seismic processing. In August we edited the project report and a draft was delivered for approval to VSC. The FKCOMB program documentation was written, edited, and delivered to VSC. We revised the project report and program documentation during September. The project report now contains a function overview of the ILLIAC IV with respect to programming, as well as an additional discussion in which we show a favorable comparison between FKCOMB results produced by the ILLIAC and the 360/91.

Other Related Work - In addition to the work described above we submitted in August a list of minimum Datalanguage requirements to VSC. We also

surveyed seismic data word formats, studied problems of nonuniformity in the context of the VELA Network, and recommended the word formats to be used at the Mass Store and on the various communication links. Finally, we developed transmission formats for the seismic network, including a general form for data status and mass store real-time data file structures, exclusive of the NEP output file(s) which are part of the NEP design.

### C. OPERATING SYSTEMS

The use of the University of Southern California's modified version of IBM's Programming System, commonly called TS44, when compared with a common program set operating under GRASP, shows significant improvements in throughput for work processed on the IBM 360/44. In the normal job stream on the 360/44 we currently are running approximately 60% Fortran jobs. Of that 60%, 74% of the run time is in compilations. Extrapolation of these figures indicates that under production running we can expect that 45% of our job stream would be reduced by a factor of 16-18 while 15% would be reduced by a factor of 3-4. The overall improvement in throughput on the 360/44 ultimately produced by the use of TS44 is a function of three variables which are: 1) the amount of time the TS44 system is used; 2) the amount of printer output generated; and 3) the number of remote terminals accessing the system. The exclusive use of TS44 will require software changes in operating programs. Regarding 2) above, we note that experience shows that a serious printer backlog can result from continual use of TS44. Finally, the proper use of a fixed number of remote terminals can reduce the printer load.

Another useful system for the 360/44 is the O/S Stage II system. In July we completed the coding for this system, and we expect to test it in the last quarter of this year. Use of the O/S system will facilitate the integration of software developed by others into our 360/44 system.

A demonstration of the Seismic Waveform Analysis Program (SWAP) on the PDP-15 computer was held in July. The Initialization Phase, Data Input Phase, and Display Manipulation Phase were illustrated.

In August additional demonstrations of SWAP were held for VSC and Teledyne Geotech Personnel, and the system was utilized several times during the month.